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$$\frac{dy}{dx}=\frac{r-2x}{2\sqrt{(rx-x^2)}},\quad \frac{dz^2}{dx^2}=1+\left(\frac{dy}{dx}\right)^2=\frac{r^2}{4(rx-x^2)},\quad z^2=r^2-x^2-y^2=r^2-rx.$$

$$\therefore\ L=2r\sqrt{r}\int_0^r\frac{dx}{\sqrt{x}}=4r^2.$$

The spherical surface removed, $S=4\int_0^r dx\int_0^{\sqrt{(rx-x^2)}}dy\sqrt{1+\left(\frac{dz}{dx}\right)^2+\left(\frac{dz}{dy}\right)^2}$

$$=4r\int_0^r dx\int_0^{\sqrt{(rx-x^2)}}\frac{dy}{\sqrt{(r^2-x^2-y^2)}}=4r\int_0^r\sin^{-1}\sqrt{\frac{x}{r+x}}.dx=(\pi-2)2r^2.$$

Note. **The results of Problem 6 in Byerly's *Integral Calculus*, page 282, 2nd Ed. (1898) are correct, if *b* represents the diameter of the cylindrical hole instead of the radius.**

Also solved by *H. C. WHITAKER.*

113. Proposed by JOHN M. COLAW, A. M., Monterey, Va.

At what rate per unit of time are the roots of the equation ($x^2+px+q=0$) changing, if $p=mq$ and q varies uniformly at the rate of 1/12 per unit of time, when $p=12$ and m remains constant?

Solution by H. C. WHITAKER, A. M., Ph. D., Manual Training School, Philadelphia, Pa.; J. SCHEFFER, A. M., Hagerstown, Md.; and G. B. M. ZERR, A. M., Ph. D., The Temple College, Philadelphia, Pa.

The roots of the given equation are

$$x=\tfrac{1}{2}[-mq\pm\sqrt{(m^2q^2-4q)}],$$
$$dx=\tfrac{1}{2}[-m\pm(m^2q-2)(m^2q^2-4q)^{-\frac{1}{2}}]dq.$$

When $q=12\div m$ and $dq=\frac{1}{12}$,

$$dx=\tfrac{1}{24}\left[-m\pm\frac{(6m-1)\sqrt{m}}{2\sqrt{(9m-3)}}\right].$$

Also solved by *WILLIAM HOOVER.*

114. Proposed by JOHN M. COLAW, A. M., Monterey, Va.

If two concentric ellipses have equal axes inclined at an angle ω, their common area is

$$A=2ab\tan^{-1}\left(\frac{2ab}{(a^2-b^2)\sin\omega}\right).$$

Solution by J. SCHEFFER, A. M., Hagerstown, Md., and J. B. GREGG, Senecaville, Ohio.

Let AB be the semi-major axis of one ellipse, and AB' that of the other, MAC and NAD being common diameters. F is the intersection of AB with the second ellipse, and E and G are the intersections of major axis of the second ellipse with the first.

Let angle $B'AB=\omega$. It can be easily shown that angle $CAF=\frac{1}{2}\omega$, and angle DAF=angle $DAG=\frac{1}{2}\pi-\frac{1}{2}\omega$.